



UNIT 2 - FUELS

SECTION 3 - WHAT ARE ALTERNATIVE FUELS?



GAS LAWS IN ACTION - PROPANE

Background Information

Propane combines many of the storage and transportation advantages of a liquid with the fuel advantages of a gas. Under normal atmospheric pressure and temperature, propane is a gas. Under moderate pressure or lower temperatures, however, propane changes into a liquid. The liquid propane is vaporized as needed to fuel vehicles or other equipment.

Charles's Law

According to Charles's law, the volume of a fixed mass of gas at a constant pressure varies directly with absolute temperature. Propane illustrates this law. As the temperature of propane gas is lowered, the molecules move closer together and the volume of the gas decreases. At minus 44° F and atmospheric pressure, propane exists as a liquid. Kept under moderate pressure (e.g., 127 pounds per square inch at 70° F), propane can be transported, delivered and stored in a closed container as a liquid. When liquid propane is vaporized for use, the resulting gas has a volume 270 times that of the liquid.

Charles's gas law:
$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Where:

V_1 = original volume of a gas sample

V_2 = new volume of a gas sample

T_1 = original absolute temperature of a gas sample (kelvin*)

T_2 = new absolute temperature of a gas sample (kelvin)

* Absolute temperature is measured in degrees kelvin. A kelvin is the same as a degree Celsius. The two differ only in having different reference points. Zero degrees Celsius is defined as the freezing point of water, but zero degrees kelvin is absolute zero. Water freezes at 273.15 kelvins and boils at 373.15 kelvins. Any temperature can be converted from Celsius to kelvins by adding 273.15.

GAS LAWS IN ACTION INVESTIGATION CONT.

Boyle's Law

Boyle's law of gases complements Charles's law. Boyle's law states that when the temperature is held constant, the volume of a fixed mass of gas in a container varies inversely with pressure. In other words, as long as the temperature doesn't change, the higher the pressure, the lower the volume of the gas, and vice versa.

Boyle's gas law: $P_1 \times V_1 = P_2 \times V_2$

Where:

P_1 = original pressure of a gas sample

V_1 = original volume of a gas sample

P_2 = new pressure of a gas sample

V_2 = new volume of a gas sample

Boyle's law explains why pressure-relief valves on propane tanks work. When the relief valve is opened, pressure inside the tank is released (lowered), as gas expands in volume and escapes through the relief valve. When the tank or cylinder is re-pressurized by closing the valve, the boiling stops and the gas and liquid inside the tank return to a state of equilibrium.

Gas Laws Work Together

Outside temperature is continually changing. The air surrounding a propane tank or cylinder transfers heat to the propane inside. When this happens, the volume of liquid and the pressure inside the tank increase. The pressure can change as much as 50 psi on a single day. To compensate, propane tanks are filled to about 80 percent of their capacity. This allows room for the propane to expand safely.

Part I: Chill It

Materials

round helium-quality balloons
thermometer
string
marker
water

helium canister
rubber band
metric ruler
wash tub
ice

GAS LAWS IN ACTION - PROPANE INVESTIGATION CONT.

Procedure

1. Fill a balloon with helium to near capacity. Hold the end; do not tie off.
2. Have one partner hold balloon while the other partner inserts a thermometer into the balloon.
3. Make sure temperature readings will be visible. Then tightly secure the thermometer inside the balloon with a rubber band.
4. Measure the circumference of the balloon. Wrap the string around the balloon at its widest point. Mark the string with the marker and measure the distance with the metric ruler.
5. Record the circumference of the balloon on the data table.
6. Measure and record the temperature of the gas particles inside the balloon.
7. Cool the gas particles inside the balloon by placing the balloon upside down (thermometer up) in a large wash tub of ice and water for three to five minutes.
8. Measure and record the temperature of the gas particles inside the balloon.
9. Take another measurement of the circumference. Be careful, because shrinking of the balloon will cause wrinkling of the surfaces.
10. Record the circumference of the balloon on the data table.
11. Share your data with other students.

Observations

Circumference of balloon (cm)	Temperature (C ⁰)	Radius	Volume (cm ³)

1. Assuming that the balloon is a sphere and using the information below, calculate the radius of each balloon _____

$$\text{Diameter} = \text{circumference} / 3.14$$

$$\text{Radius} = 1/2 \text{ diameter}$$

2. Again assuming the balloon is a sphere and using the information below, calculate the volume of the balloon _____

$$\text{Volume} = 4.0 \times 3.14 (\text{radius} \times \text{radius} \times \text{radius}) / 3.0$$

GAS LAWS IN ACTION - PROPANE INVESTIGATION CONT.

3. Calculate the volume of the balloon after it was plunged into the ice bath.

Graph the relationship between volume and temperature for all balloons.

[illegible]

Part II: The Big Squeeze

Procedure

1. Move the desks in the classroom to form a large square with open space in the middle.
2. Pick four to eight students to represent gas molecules.
3. Using the formula below, calculate the volume of the space. Use the height of the tallest student as the height of the cube.

volume of a cube = length x width x height

- Record the volume of the space on the data table.
- The students that represent the gas molecules should move to the middle of the square, blindfolded and with arms across their chests.

**GAS LAWS IN ACTION - PROPANE
INVESTIGATION CONT.**

6. One student should be given the task of timekeeper. This student should keep time by clapping or beating out a rhythm that dictates the speed of the gas molecules. This student should watch a clock and use a time interval of four seconds for each clap.
7. The remaining students should sit at the desks and record the number of collisions that occur in one minute between gas molecules and between gas molecules and the edges of the container (desks).
8. When the timekeeper is ready, the gas molecules are to walk with the beat of the timekeeper, using small steps, until they collide with another gas molecule or the edges of the container. Once a collision occurs, students are to back away from the collision again, slowly, still keeping pace with the timekeeper until they collide again.
9. If desks are moved slightly when collisions occur, the recorders are to quickly move the desks back into place.
10. Recorders post their results on the board.
11. Repeat the experiment 3 times.
12. Move the desks in to create a smaller space.
13. Predict the number of collisions that will occur within the smaller space.
14. Repeat steps 2-10.
15. Calculate the average number of collisions for each trial.
16. Record the class averages as pressure on the data table.

Trial	Volume (cm ³)	Pressure
1		
2		
3		
1		
2		
3		

GAS LAWS IN ACTION - PROPANE INVESTIGATION CONT.

Graph the relationship between volume and pressure.

[illegible]

Conclusion

1. Describe the relationship between temperature and volume of a gas. _____

2. Demonstrate, by using the formula for Charles's law, that the data collected support this gas law. _____
3. Describe the relationship between volume and pressure. _____

4. What phase did the molecules represent when the desks were in the first position?

**GAS LAWS IN ACTION - PROPANE
INVESTIGATION CONT.**

5. Explain what was being demonstrated in terms of pressure, volume, and phase when the desks were moved closer together. _____

6. Demonstrate, by using the formula for Boyle's law, that the data collected supports this law.

Application

7. When a propane tank warms during the heat of the day, what happens to the volume?
_____ Why? _____
8. At atmospheric pressure, propane gas can be liquefied by cooling it to _____.
Below this temperature, the gas will not vaporize.
9. Propane can be cooled to this temperature by first _____ the gas, and then
allowing it to expand rapidly, which cools the gas.
10. When a can of pressurized liquid, such as hair spray, is shaken the liquid inside can be heard
sloshing around. Then, when the nozzle is pushed down the _____ in the can
decreases.
11. How do the results from pushing the nozzle on a hair spray can relate to propane stored in
a tank? _____

Going Further

12. Work together in a group to design another chemistry theater that would demonstrate
Charles's law.



UNIT 2 - FUELS

SECTION 3 - WHAT ARE ALTERNATIVE FUELS?



CONCEPT MAPPING ALTERNATIVE FUELS

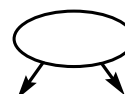
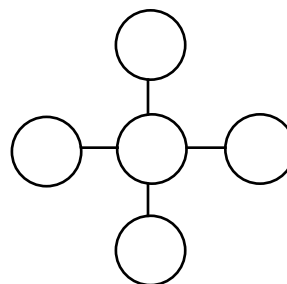
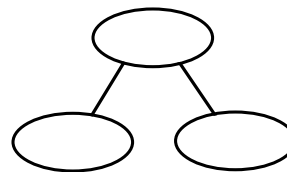
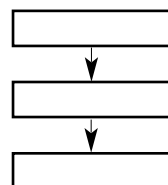
Background Information

A concept map is a way of representing relations between ideas, images or words, in the same way that a sentence diagram represents the grammar of a sentence, a road map represents the locations of highways and towns, or a circuit diagram represents the workings of an electrical appliance.

In a concept map, each word or phrase is connected to another and linked back to the original idea, word or phrase. Concept maps are a way to develop logical thinking and study skills, by revealing connections and helping students see how individual ideas form a larger whole.

Concept maps are flexible. They can be made simple or detailed, linear, branched, radiating, or cross-linked.

- Linear concept maps are like flow charts that show how one concept or event leads to another.
- Hierarchical concept maps represent information in a descending order of importance. The key concept is on top, and subordinate concepts fall below.
- Spider concept maps have a central or unifying theme in the center of the map. Outwardly radiating sub-themes surround the main theme. Spider concept maps are useful for brainstorming or at other times when the relationships between the themes need to be left open-ended.
- Cross-linked maps use a descriptive word or phrase and identify the relationship with a labeled arrow.



**CONCEPT MAPPING ALTERNATIVE FUELS
INVESTIGATION CONT.**

What Are Alternative Fuels? introduces fuels for vehicles other than the petroleum-based fuels now in conventional use. These alternative fuels include biodiesel, ethanol, hydrogen, methanol, natural gas, and propane.

In this activity you will create a concept map comparing and contrasting alternative fuels.

Problem *(fill in problem):* _____

Materials

1 large piece of paper
markers

"Alternative Fuels and Their Characteristics" (Appendices, pp. 412 - 413)

Procedure

1. The first step in creating a concept map is to decide on a main topic or idea, print it in the middle of the page, and draw a shape around the words. The main topic in this lesson is alternative fuels.
2. Read "Alternative Fuels and Their Characteristics." Look for ways that you can compare and contrast the fuels. Some examples of classification schemes are: chemical class (e.g., paraffins, alkanes, alcohols), substance type (e.g., mixture, compound, element), phase (gas, liquid) and source (biofuels, fossil fuels, synthesized fuels). Refer back to the concept map you created on "Fuels for Everything." The classification schemes are similar to the major concepts you used in that lesson.
3. Using a cross-linked technique, draw a short line down from the shape that contains the words Alternative Fuels. Write the first classification scheme at the bottom of the line. Draw another short line going down for each classification e.g., paraffin, alcohol, element.
4. Draw a shape around each classification. Draw another short line going down.
5. Follow this same procedure for each of the classification schemes.

**CONCEPT MAPPING ALTERNATIVE FUELS
INVESTIGATION CONT.****Observations**

1. Compare and contrast diesel and reformulated gasoline to liquefied natural gas, compressed natural gas, and propane. _____

2. Compare and contrast syngas, biogas, and methanol. _____

3. Compare and contrast hydrogen and methanol. _____

4. Compare and contrast ethanol and methanol. _____

Application

The background information included three ways to make a concept map besides the linear technique. They were: branched, hierarchical and cross-linked. Concept maps can also include pictures instead of words or phrases. Pick one different type of mapping and create a new concept map.